MEN SELECTED FOR THE TESTS

Seven men prisoners were selected for the tests, as follows:

	Age	Weight	Occupation	Crime	Time Served
Subject 1	20	130	Lab. tech.	Murder	3 years
Subject 2	38	215	Druggist	Robbery	4 years
Subject 3	47	126	Doorkeeper	Kidnaping	10 years
Subject 4	31	173	Surg. nurse	Murder	8 years
Subject 5	42	172	Surg. nurse	Murder	4 years
Subject 6	33	130	Lab. tech.	Murder	9 years
Subject 7	30	140	Lab. tech.	Murder	11 years

PROCEDURE

For ten days, January 18 to January 30, 1931, a normal was established.

During the next ten days, January 30 to February 9, a quarter of a pound of cake was given to each of the seven subjects on going to bed.

For ten days, February 9 to February 20, a quarter of a pound of eggs or meats was given to each of the seven subjects before retiring.

During the last ten days of the experiment each of the seven subjects was given one ounce of butter on toast at bed time.

The movements during the sleeping periods for each of these three procedures were recorded on the kymograph and subsequently counted.

These figures are shown in the following tables:

CHART 1.—*Average Number of Movements Per Hour on Normal Diet*

Date	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Subject 7	Average for Group
Jan. 18	4.7	11.6	3.0	11.1	11.5	4.9	7.2	7.7
Jan. 19	3.4	11.1	4.6	11.2	12.5	4.1	8.4	7.9
Jan. 20	6.2	6.0	4.0	13.2	12.5	3.6	5.9	7.5
Jan. 21	4.1	9.0	3.7	9.9	11.3	4.4	8.1	7.2
Jan. 23	8.1	9.8	6.3	5.6	14.5	10.1	7.5	8.8
Jan. 24	5.0	7.7	5.1	11.3	8.5	3.0	6.4	6.7
Jan. 25	5.7	8.8	7.1	6.3	12.3	3.5	9.3	7.5
Jan. 26	4.8	12.1	....	12.1	10.3	3.7	5.4	8.0
Jan. 27	4.0	14.3	3.2	15.4	11.4	5.0	8.2	8.8
Jan. 29	6.6	11.2	3.3	11.2	10.1	5.3	6.7	7.8
Period Average								7.89

CHART 2.—*Average Number of Movements Per Hour on Carbohydrate Diet (One-Quarter Pound of Cake)*

Date	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Subject 7	Average for Group
Jan. 30	6.4	10.0	3.8	16.0	9.2	5.5	8.7	8.5
Jan. 31	....	8.3	4.1	16.4	11.2	5.5	5.6	8.5
Feb. 1	7.7	9.1	4.0	.....	9.0	6.0	7.7	7.3
Feb. 2	7.8	7.9	4.4	6.7	10.6	5.0	10.8	7.5
Feb. 3	6.6	12.3	5.8	10.4	10.2	6.2	7.8	8.4
Feb. 4	6.4	12.1	5.4	9.4	10.9	6.2	10.7	8.6
Feb. 5	6.3	11.7	6.4	10.9	10.0	6.5	9.6	8.8
Feb. 6	7.2	11.8	5.6	9.1	11.1	7.0	9.0	8.6
Feb. 7	10.2	13.0	3.6	10.1	14.0	5.3	11.1	9.6
Feb. 8	10.0	14.6	6.0	11.4	9.3	7.1	9.5	9.7
Period Average								8.56

CHART 3.—*Average Number of Movements Per Hour on a Protein Diet (One-Quarter Pound of Eggs or Meat)*

Date	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Subject 7	Average for Group
Feb. 9	9.3	12.0	4.0	12.0	11.3	6.3	9.3	9.1
Feb. 10	6.7	16.7	5.7	13.0	11.3	6.5	9.6	9.9
Feb. 11	6.0	9.7	4.4	11.4	10.6	5.5	9.4	8.1
Feb. 12	5.5	10.6	4.4	10.2	11.8	7.6	9.1	8.4
Feb. 13	6.0	15.7	4.0	11.0	11.1	6.0	10.4	9.1
Feb. 14	5.1	9.8	3.3	11.0	12.6	5.7	9.0	8.1
Feb. 16	9.3	11.2	4.1	15.0	12.8	6.0	9.3	9.6
Feb. 17	9.2	11.0	6.1	14.0	14.3	5.8	8.8	9.9
Feb. 18	10.5	9.8	5.3	9.7	10.2	5.6	9.6	8.7
Feb. 19	8.0	10.8	5.2	13.5	17.9	4.5	10.5	10.0
Period Average								9.0

CHART 4.—*Average Number of Movements Per Hour on a Fat Diet (One Ounce of Butter)*

Date	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Subject 7	Average for Group
Feb. 20	10.0	11.8	4.4	11.3	13.8	6.1	7.6	7.8
Feb. 21	9.2	13.0	4.0	.....	12.4	7.0	8.7	9.0
Feb. 22	8.3	11.4	3.0	.....	13.5	6.4	....	8.5
Feb. 24	8.8	18.6	2.3	13.3	12.0	4.9	7.9	9.6
Feb. 25	8.0	9.2	3.2	12.5	8.0	6.0	9.3	8.0
Feb. 26	....	9.8	4.4	10.0	13.6	5.0	8.1	8.5
Feb. 27	11.2	18.0	....	12.8	12.4	8.2	7.8	10.7
Feb. 28	9.2	11.4	6.3	9.8	13.0	6.2	6.6	8.9
Mar. 1	8.1	10.2	5.8	....	16.0	4.7	7.7	8.7
Mar. 2	6.6	8.5	....	....	10.6	6.2	7.7	7.9
Period Average								8.76

CHART 5.—*Summary of Average of All*

Normal—Nothing taken	7.89 movements per hour
Carbohydrate diet	8.56 movements per hour
Fatty diet	8.76 movements per hour
Protein diet	9.00 movements per hour

COMMENT

These figures would seem to indicate that a more restful sleep is had if nothing is eaten on going to bed.

But a protein diet causes more disturbance of rest than either one of fat or of carbohydrates.

Of the three, there is less restlessness with the taking of carbohydrates.

San Quentin.

FRACTURES OF THE OS CALCIS*

By MAYNARD C. HARDING, M. D.
San Diego

DISCUSSION *by Edward N. Reed, M. D., Santa Monica; Fred Fairchild, M. D., Woodland; Fraser L. Macpherson, M. D., San Diego.*

THE frequency of fractures of the os calcis is growing with the increase of all types of fracture. Its relative frequency seems to depend on the amount of construction in a given locality, since it is largely a fracture of falls from a height of ten feet or more. Ellison,[9] in 1927, stated that it constituted three-tenths of one per cent of all fractures. In a recent article he increased it to two per cent. Herman[4] estimated it at two per cent. My own experience places it at about one per cent.

Following Cotton's papers on the treatment of os calcis fractures in 1908 and 1911, not much had been written on the subject until my article in the *Journal of Bone and Joint Surgery* in 1926,[10] setting forth the method the author had used since 1917. This present paper deals with the further use of this method, with modifications suggested by experience.

As is well known, nearly all these fractures are caused by falls on the feet. A few may be direct crushes, or the posterior end of the heel may be bitten off by a shearing force such as a descending elevator.

* Read before the General Surgery Section of the California Medical Association at the sixtieth annual session, San Francisco, April 27-30, 1931.

CLASSIFICATION OF HEEL FRACTURES

Recent authors have classified heel fractures in several ways, some of which are quite complex. It seems to me that the earlier and more simple classification is best, as it is directly related to the different methods of treatment.

First, may be considered the fracture of the posterior part of the heel not entering the subastragaloid joint. The deformity is generally directly upward displacement. The reduction is a simple problem, even though often difficult.

Second, may be considered the fractures entering the subastragaloid or calcaneocuboid joint, but without broadening of the os calcis. Here the problem of painful stiffening of the joints enters. Further experience has shown me that, while subastragaloid stiffening is one of the most disabling results, calcaneocuboid pathology is a marked factor of disability in some cases.

Third, may be considered the smash fracture. Here we have the familiar picture of a heel bone which is shortened fore and aft and broadened until it may project beyond the malleoli. The posterior end is thrust up and the arch flattened, often with marked rupture of the plantar facia and ligaments. Comminution into the subastragaloid and calcaneocuboid joints gives a rough articular surface, beyond the reach of any manipulation to smooth out. This third type is the one we ordinarily think of. It is the one that Cotton classified as causing disability second only to fractures of the neck of the femur. The disability runs true to form, according to the pathology. Pain under the heel on walking is due to pressure on callus in the sole. This results from insufficient reduction downward of the posterior fragment, so that weight is being borne on the fracture line instead of on the tuberosities where nature intended it to be borne. Extensive plantar ligament tear may also be a factor, but is rarely so persistent. The most common disability is due to broadening and to a rough subastragaloid joint. Broadening interferes with lateral motion so necessary in walking on uneven ground, while it also impinges on the pereonei tendons as they pass through the mortise under the tip of the external malleolus. Impaired lateral motion does not necessarily cause pain, for nearly all of these types have some restriction as an end result. It is likely that the very painful cases have a joint irregularity from a fragment that acts like a locking joint mouse in the knee. This has a definite bearing on reduction. Where the fracture line penetrates the calcaneocuboid joint, a further factor of foot stiffness, with varying degrees of pain, is introduced. This stiffness may involve all the midtarsal joints, remaining for months in spite of persistent physiotherapy. I believe it to be due to scar tissue following extensive rupture of the fibrous investment which holds the bones of the foot together. Occasionally, of course, there is an inflammation with some infectious complication, but the force of the injury will account for most of the symptoms.

DIAGNOSIS

A diagnosis is made on the history of a fall on the feet, together with marked bulbous swelling and characteristic localized pain on pressure and manipulation. The heel may be markedly shortened and the arch lost. Broadening is often extreme. The exact type of fracture can be told only by the x-ray. The customary anteroposterior and lateral foot views are not enough to bring out all the pathology. The following position, worked out many years ago by Dr. Lyell C. Kinney, is also necessary:

"The patient is placed prone on the end of the table with the foot in dorsal flexion, the plate against the sole of the foot. The tube is shifted so the central ray is perpendicular to the axis of the os calcis. This is of great importance, as it shows both lateral broadening and lateral angulation or displacement of the posterior fragment."

TREATMENT

Let us consider the treatment of the "smash" fracture, bearing in mind the pathology just outlined, as well as the customary results with their causes. It is a surgical axiom to restore broken bones as nearly as possible to their original form. Our proposition here is:

1. To bring down the posterior end of the heel until the inferior tuberosities are the most dependant part (this is to prevent pain in the sole on weight bearing).

2. To break up impaction and remould the bone to approximately its normal width, remembering that if much comminution exists, some shortening and broadening will remain after the most careful reduction.

3. To restore the arch.

4. To secure as free a motion as possible in the subastragaloid and calcaneocuboid joints.

Most of the recent authors are agreed on the first two points in reduction. Some of them stress the third, but none the fourth.

There is considerable unanimity in advocating Cotton's mallet impaction for broadening, and the use of traction downward on the heel. Ellison [1] uses impaction and traction by tongs or tendon lengthening. Allison [3] advises operation and primary subastragaloid arthrodesis of the majority. Herman [4] uses mallet impaction and traction by tongs or pin. Wilson [5] advises arthrodesis of all. Nutter [7] also advises arthrodesis of all. Buehler uses traction and countertraction by a Steinman pin through the os calcis and one through the tibia, with clamp impaction.

Author's Method.—The following method to be described was worked out by the author in an attempt to bring adequate force to bear in correction of all the deformity so far as possible. The instruments needed are: (1) a common D clamp used by carpenters; (2) a pair of felt-padded boards 1 x 2 inches in size; (3) a triangular wooden wedge four inches high; (4) a pair of skeletal traction tongs or a four-prong sharp retractor; (5) a hammer.

The patient's leg is bent over the side of the table with the foot placed on the wedge which rests on a stool of suitable height. No adequate relaxation of the uncut Achilles can be obtained with a straight leg. I have never found it necessary to do a tenotomy if this position has been used. The surgeon sits on a low stool or bench. His assistant sits on a bench or on the floor. If tongs are used they are seated in stab wounds as far back as a good hold can be obtained. If the retractor is used, seat it deeply at the attachment of the Achilles by a sharp blow of the hammer. It has proved very satisfactory in most of the cases. Possibly a little better backward pull can be obtained by the use of tongs.

The surgeon holds the foot in extreme plantar flexion over the wedge. The assistant makes strong downward traction on the retractor. This should restore the arch and draw down the posterior fragment. If there is difficulty in unlocking the fragments, traction backward and then downward is made and repeated. The thickness of the well heel is measured and noted, using the clamp as a caliper. The pads are applied to the sides of the fractured heel and the clamp screwed up slowly to dissipate the swelling. Then strongly to mould the bone, all the while maintaining strong downward traction on the forefoot and heel. Further downward correction can be made during compression. The pads are shifted several times, compression being continued until the two heels compare favorably in width. Then, with the clamp firmly set, use it as a wrench to produce lateral rocking in the subastragaloid joint. Also mobilize the midtarsal joints. If good motion can be obtained at this time, in all probability it will be retained. I am convinced that this is important.

Remove the clamp, wedge, and stool. Apply a snug cast while maintaining plantar flexion and strong heel traction. Just before the plaster sets, put the pads on the outside of the cast and mould the plaster in with the clamp until the heel is tightly clasped. As soon as the plaster has set, remove the clamp and retractor. The cast is then carried to midthigh with the knee at 135 degrees, to keep the Achilles relaxed.

The after-care is quite simple. The cast may be removed in four or five weeks, when active motion and physiotherapy are begun. In about six weeks the patient can bear weight on the ball of the foot. In eight weeks he is fitted with a felt arch supporter and allowed to walk on the whole foot.

COMMENT

The results have been surprisingly good. As stated before, nearly all of these heels have some limitations of motion and some changes in shape. There are twenty-six cases in the series treated by this method. Three are too recent to know the end results. The other patients have returned to their ordinary work. Their average period of disability was between five and six months. None have had any further operations.

There are three types of heel fracture that need open reduction. In fractures of the posterior half, when the fragment cannot be brought down by manipulation, a horseshoe incision running as far forward as the fracture line on the outer side is made and the bone exposed. An attempt is made, with the knee flexed and the foot in plantar flexion, to lever the fragment down into place. If this is not possible, do a diagonal section of the Achilles. Hold the fragment with a beef-bone screw or a nail. Cast as in the other fracture.

For those old cases with persistent pain in the subastragaloid region or with excess bone under the external malleolus, make a curved incision under the tip of the fibula and remove excess bone. Next enter the subastragaloid joint and remove all cartilage in sight, producing an arthrodesis. This is entirely satisfactory as a pain reliever in the majority of cases. The resultant stiffness is gradually overlooked, provided mobile midtarsal joints are secured.

In that type of cases where the patient is walking on tender callus in the sole, make an external incision parallel to the plantar surface and chisel away enough callus to leave the tuberosities the most dependent part. These patients, particularly, need an arch support, preferably flexible.

IN CONCLUSION

It is unfortunate that many surgeons cling to the belief that a cast in the position of deformity is good treatment. I see several patients a year for insurance companies where no further treatment has been attempted. Nothing but arthrodesis with remodeling remains for these patients after a year or more spent in trying to make a painless joint by physiotherapy. At the other extreme is the unjustified pessimism that is leading some men to immediate operation. Surely every case is entitled to have at least the manipulation described here. If this can produce a good result, why operate?

700 Electric Building.

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DISCUSSION

EDWARD N. REED, M. D. (301 Professional Building, Santa Monica).—Doctor Harding has insisted for years on two considerations which are apt to be overlooked, in the consideration of the gross deformity of a severe os calcis fracture, yet which are of primary importance to recovery of function. I refer to the involvement of the subastragaloid and calcaneocuboid joints; and to development of a weight-bearing surface in front of the tuberosity of the os calcis, and usually within the area of attachment of the plantar ligaments.

Dr. Andrew R. MacAusland remarks that: "It is a paradox that a slight injury to an os calcis, with fracture, will give you more prolonged disability than a severe injury." This because the severe injury usually produces an arthrodesis of the subastragaloid joint.

Several methods are advocated for reduction of os calcis fractures. I have used Doctor Harding's method a number of times and have had good success with it. The need for reducing the deformity, by whatever method, is obvious. But I believe that Doctor Harding's insistence on securing free movement through normal range, in the subastragaloid and midtarsal joints, at the end of the reduction, is not sufficiently stressed.

Producing this movement tends to iron down edges of fragments which project into the joint space, and to smooth out the articular surface. It is these edges and spicules projecting into the joint space, which, after consolidation has taken place, cause the pain in walking on uneven surfaces.

To guard against a painful weight-bearing surface on the bottom of the heel, the restoration of the tuberosity to its position as the lowest level of the os calcis must be insured. The Achilles tendon must be slacked off by dressing the leg in knee flexion and foot drop. Even with this position I have sometimes felt safe only with a pin introduced through the bone and incorporated in the plaster cast; and have never had any trouble from the pin.

Such a pin through the bone makes the manipulation of reduction surer and easier and I believe is the method of choice where the position of the posterior fragment requires considerable alteration.

In its end results fracture of the os calcis is one of the most disabling of all fractures. My own experience is in agreement with Doctor Harding's, that these fractured os calces do not all require immediate arthrodesing operation but that many can be restored to painless function by the method he has outlined.

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Fred R. Fairchild, (Woodland Clinic, Woodland).—We are in agreement with Doctor Harding's opinion that fractures of the os calcis seem to be becoming relatively more frequent. For the past ten months, of all fractures treated by us, seven were of the os calcis, approximately two per cent for this ten months' period.

We would stress the necessity for the examination of the spine in all fractures of the os calcis since the type of violence causing this lesion is such as to make an associated compression of the vertebral body not infrequent.

The classification of os calcis fractures as outlined by Doctor Harding seems excellent. We have used Wilson's classification and divide fractures of the os calcis into isolated fractures and into fractures of the body of the bone, considering the latter under the broad subdivisions of fissured and comminuted fractures.

In the first type of fracture we have no hesitation in using a pin or preferably a wire if the reduction is difficult. In the second type we feel that there is great danger in using a pin as there is the possibility of changing a simple fracture into a compound one by this method. This rarely happens; but once having seen it, the danger is not easily discounted.

We agree with others that fractures of the os calcis are very disabling when they extend into the subastragaloid or the calcaneocuboid joint. We have felt that the majority of such fractures require a fusion and we have noted that in all such fractures, at the time of operation, the irregularity of joint surfaces is much more pronounced than one would be led to have supposed from the x-ray.

We also feel that it is important when x-raying the fracture, that a plantar view be taken as well as an anteroposterior and lateral, as we have several times demonstrated a fracture by a plantar view that would otherwise have been missed.

We are in accord with Doctor Wilson's opinion that the amount of motion recovered in a severe fracture of the os calcis involving the subastragaloid or calcaneocuboid joint, or both, is very little, and that generally such motion while not materially aiding function causes pain.

Our experience convinces us that in a bad fracture of the os calcis a fusion operation gets the patient back to work much sooner than by any other treatment. Too frequently those conservatively treated eventually come to a fusion. We are inclined in severe os calcis fractures to advise immediate arthrodesis.

It is most gratifying to know that Doctor Harding by his conservative method has had such excellent success. Possibly the pendulum is swinging too far toward the side of surgical treatment. Very likely the method of choice will ultimately be found to be somewhere between the two extremes.

❦

Fraser L. Macpherson, M. D. (610 Medico-Dental Building, San Diego).—For the past five years I have had the opportunity of seeing many of Doctor Harding's patients and have also used the same method in my own practice.

It is surprising the amount of anatomical reduction that is possible in these severely smashed fractures of the os calcis. Many of the severely comminuted fractures of course cannot be anatomically reduced, but by this method the alignment of the subastragaloid joint is much better restored than by any of the other methods described.

Another advantage of this method is that the patient is able to be put in a plaster cast immediately and the length of time spent in the hospital is thereby greatly lessened.

I feel this is the method of choice in reducing this type of fracture.

FAVUS IN CALIFORNIA*

REPORT OF CASE DUE TO A STRAIN PATHOGENIC FOR MICE

By Stuart C. Way, M. D.
San Francisco
AND
Fred D. Weidman, M. D.
Philadelphia, Pa.

Discussion *by Samuel Ayres, Jr., M. D., Los Angeles; Hiram E. Miller, M. D., San Francisco; Ernest K. Stratton, M. D., San Francisco; Harry E. Alderson, M. D., San Francisco.*

DISEASES of the skin produced by fungi of the achorion or allied groups and characterized by typical scutula are extremely rare on the Pacific Coast. According to Crutchfield, Michael, and Shelmire, few cases of favus have been observed in our southwestern states, although other forms of fungus infection are extremely prevalent.

In 1926 Frost and Koetter reported a case of favus, but in a recent communication from one of them [1] doubt was expressed as to whether this diagnosis should not be revised.

Since the literature fails to reveal additional cases of favus occurring in California, it is assumed that this is the first case to be actually published, although various physicians have verbally stated that they have seen examples of the disease.

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* Read before the Dermatology and Syphilology Section of the California Medical Association at the sixtieth annual session at San Francisco, April 27-30, 1931.